Toward Cross-Sectoral Team Science

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Introduction

The papers in this supplement to the *American Journal of Preventive Medicine*[1–15] reflect the growing awareness that in an age of open-source innovation and collaboration, it has become increasingly urgent to understand when and how to foster and enhance transdisciplinary research in fields including prevention and public health. Collaborative approaches make sense in these fields because many of the problems are complex, require action across traditional boundaries or communities of interest, and are susceptible to "tragedy of the commons"[16] and "free rider" issues. *Heterosis*, better known in high school biology as hybrid vigor, can arguably apply equally to public health and research programs as to strains of corn, and combining the best from several approaches may well help to transform current research structures and incentives to better enable so-called *team science* to fulfill its promise.

The NIH and National Academies, among other groups, increasingly have recognized the usefulness of interdisciplinary and collaborative approaches to complex problems.[17] To be sure, these have potential downsides or limitations; for example, Yale psychologist Irving Janis's concept of "groupthink,"[18] Fred Brooks' point in *The Mythical Man-Month*[19] that increasing the size of a project team can perversely incur crippling inefficiencies and coordination costs; or the difficulties in the training, promotion, and retention of scholars who don't fit neatly within existing departmental boundaries.[20] For the most part, however, two heads are better than one, the wisdom of crowds[21] trumps that of most individuals, and tackling complex research questions from multiple angles confers advantage.

Thus, while many academic research groups, for-profit companies, and even philanthropies still largely operate in an insular, competitive mode, a few notable exceptions are exploring—and finding success in—alternative models. Examples of these collaborative, cross-sectoral efforts in biomedical science include various recipients of the NIH "P" series grants; the SNP (single nucleotide polymorphism) Consortium and HapMap Project; the BioBricks Foundation; the Public Library of Science; and similar initiatives in Canada[22] and the European Union.[23] Others with more of a public health flavor include the NIH exploratory centers for interdisciplinary research[24] and its program on public–private partnerships,[25] the Grand Challenges for Global Health initiative,[26] and the WHO-sponsored Medicines for Malaria Venture.[27] Well-known examples in industry include InnoCentive,[28] which posts problems from "seekers" and awards bounties to "solvers"; and P&G's Connect + Develop program,[29] which fosters external sources of product ideas.

Of course, the term *collaborative research* is a broad rubric, and this article will not discuss, for example, efforts such as Folding@home or FightAIDS@home, which use spare computing power donated by thousands of individuals around the world to enable powerful computing platforms for molecular modeling and drug discovery.[30] Rather, we will focus on three conceptual dimensions reflected in the rapidly expanding literature on research collaborations:

Team: collaborations across laboratories or institutions;

Approach: collaborations across disciplines, whether the approach is multidisciplinary, interdisciplinary, or transdisciplinary; and

Goal: collaboration across translational stage, that is, the spectrum from basic research through applied research or development, to sustainable implementation or commercialization.

These **TAG** dimensions are illustrated in Figure 1, and are elaborated below.

In Figure 1, three dimensions of collaboration define a space in which we can locate various types of research efforts. Point A represents a minimally collaborative, somewhat traditional model of basic research within a single discipline, and laboratory or institution. In contrast, Point B denotes a multi-institutional research collaboration within a single discipline, as often occurs among professional colleagues who happen to be located in different labs or universities. Similarly, Point C indicates a multidisciplinary/interdisciplinary collaboration within a single institution, for example, experts in public health, law, and behavioral science working together to study issues around tobacco advertising.

While the above points are located in the "back plane" of the diagram, representing predominantly academic research with little intention to translate into large-scale, sustainable implementations or commercialization, other points "in front" of this back plane

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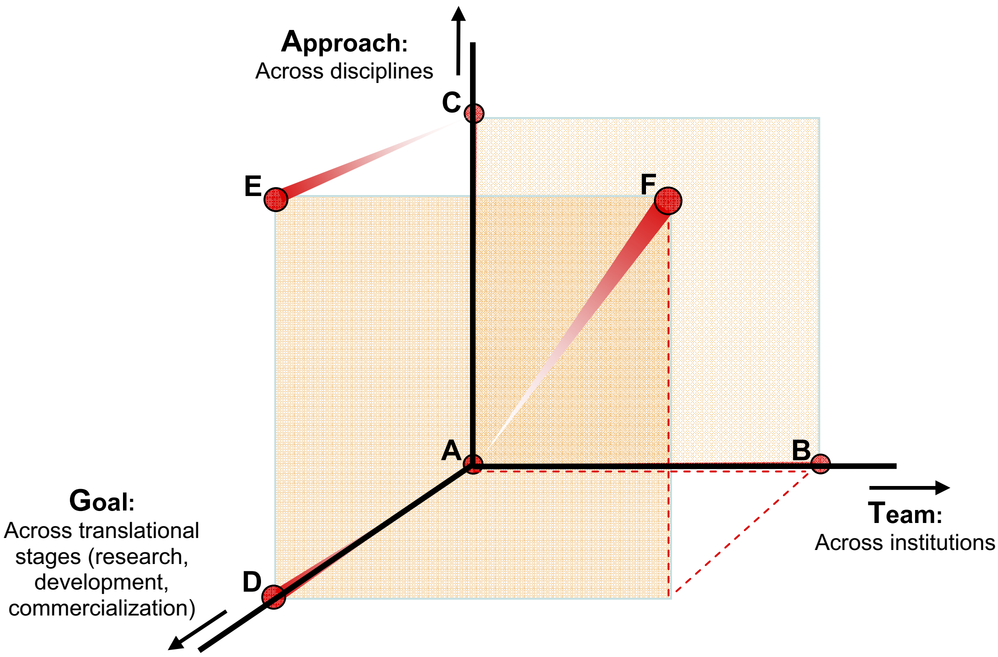

Figure 1. Dimensions of collaboration

represent efforts along the spectrum of translation, from basic research through applied research, to the development and scaling up of actual products or solutions. Point D, for example, could represent a project in a traditional industrial central research lab or a clinical process–improvement group, in which the work occurs more or less within a single discipline and within a single institution, but aims to build from basic or applied research to create a real-world intervention or solution. Point E, on the other hand, might describe a traditional commercial product–development effort, in which several disciplines (e.g., ethnography, design, engineering, legal/regulatory, marketing, and sales) are brought to bear on getting a product onto the market. Finally, Point F would represent a multi-institutional, multidisciplinary/interdisciplinary collaboration across translational stages, as the two dozen NIH-sponsored Clinical and Translational Science Awards (CTSA)[31] centers or numerous small business innovation research (SBIR) grant recipients are beginning to exemplify.

Since the inherent nature of prevention and public health tends to produce pragmatic, implementable solutions linked to measurable improvements in population outcomes, research in those fields tends to move off of the back plane of Figure 1, in contrast to academic disciplines in which, as Chesbrough observes, "unsurprisingly, when an organization rewards the quantity of patents or papers produced, the R&D organization responds by generating a large number of patents or papers, with little regard as to their eventual business relevance."[32] Additional impediments to establishing cross-sectoral collaborations among universities, government funding agencies, private corporations, foundations, and nongovernmental organizations are described in the proceedings of the 2007 National Cancer Institute Conference on the Future of Consumer Health Information Technologies.[33]

What are some specific strategies for encouraging and implementing collaborative research? In the academic sphere, a 2004 survey by the National Academies suggested that interdisciplinary research could best be promoted by fostering a collaborative environment, providing faculty incentives (including hiring and tenure policies), and providing seed money for interdisciplinary pilots.[34] In the for-profit sphere, companies have collaborated with universities over the years, supporting path-finding research through grants, donations in kind, bidirectional internships or sabbaticals, and even setting up "lablets" on or adjacent to university campuses.[32] Intel's Digital Health group has built on this history and has implemented a "research commons" model along with a number of universities. The reasoning is that one way to accelerate progress in an emerging field is to reduce unnecessary redundancy. Under this arrangement, research groups at different universities each chip in and cross-license tools and technology; original inventors retain rights over their intellectual property, but in the meantime, investigators don't have to spend (for example) the first 3 years of a 4-year grant re-inventing technology that already exists at another university before getting to the outcome studies that are the actual point of interest.

In addition to academia, industry, and government, at least two other categories of new entrants and partners are entering the research ecosystem. One category includes consumers or patients themselves, who can contribute to Web 2.0 initiatives[35] such as "crowdsourcing," user-generated content, and self-organization into patient advocacy and support groups. The other, partially overlapping, category of new research partners is private philanthropy. With an estimated \$300 billion in philanthropic contributions in the U.S. in 2006, of which roughly 17% were to medical institutions,[36] even if only a fraction of this flows to research, philanthropies represent a source of funding not far behind the \$28 billion annual NIH budget.[37] Donor-sponsored research, while not uncontroversial, has injected new funds and energy into particular disease areas and can complement federal research funding to help focus on public health issues, support transdisciplinary research, fund infrastructure and overhead, and encourage new organizational structures.[38,39]

Looking ahead, it seems likely that the blurring of institutional, disciplinary, and translational boundaries by various TAG teams comprising diverse combinations of researchers, industry partners, patients, and philanthropies will spawn new research arrangements, accelerate discovery, and ultimately improve population health outcomes. The papers in this supplement mark some of the early milestones in that evolution.

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